32. (Amended) The method of claim 29 for developing and removing said photosensitive polyimide to leave said alignment posts in the location of the exposed polyimide described herein, and removing said photoresist mask.

REMARKS

Examiner Jeff B. Vockrodt is thanked for thoroughly reviewing the instant application and for examining the Prior Art.

Examiner is also thanked for the indication of allowing claims 13-32 if these claims are rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claims 8-32 are pending under this Office Action.

Favorable reconsideration of this application in light of the above amendments and the following remarks is respectfully requested.

The invention provides five new methods for the formation of an improved liquid-crystal-on-silicon display. The device structure is enhanced by the photolithographic creation of

alignment posts among the mirror pixels of the micro-display. The five methods accommodate the fabrication of an optical interference multilayer, which improves the image quality of the reflected light. The five methods of the invention provide:

- silicon dioxide posts by wet etching
- amorphous silicon posts by plasma etching
- silicon nitride posts by plug filling
- insulation material posts by lift-off, and
- polyimide posts by photosensitive etching.

Claim Objections

Reconsideration of objection to claim 8 is respectfully requested based on the following.

Claim 8 has been amended by replacing the term "silicon oxide" with "first metallic layer", the original entry of silicon oxide did not agree with the specification and was therefore incorrect. No new mater has been introduced with this amendment.

In light of the foregoing response, applicant respectfully requests that the Examiner's objection to claim 8 be withdrawn.

Claim rejections - 35 U.S.C. § 103(a)

1. Reconsideration of the rejection of claim 8 under 35 U.S.C 103(a) as being unpatentable over Wong (US 6,027,999) in view of Moore (US Patent 6,124,912) is respectfully requested based on the following.

Applicant is not able to locate any supporting evidence indicating that Wong et al. teaches the combined creation of insulating material alignment posts with optical interference layers.

Applicant has carefully analyzed the Wong et al. specification and quotes from the Wong et al. invention, as follows:

- col. 3, lines 2 e.a.: "vias are opened through the dielectric layer 24 and filled, for example, by a tungsten plug process"
- col. 3, lines 13 e.a.: "a tungsten layer is deposited over the insulating layer and within the via openings and then etched back to form tungsten plugs 38."
- col. 3, lines 22 e.a.:" a thin metal layer is deposited over the insulating layer and tungsten plugs, 36 and 28, respectively"

- col. 3, lines 25 e.a.: "the metal layer is patterned to form the metal pixels 42, as shown in Fig. 4."

A passivation stack is next formed over the metal pixels that rest on the metal alignment posts, the passivation stack comprises a lower layer of passivation (layer 44) and an upper layer of silicon nitride (layer 46).

Examiner suggests that these latter two layers form the alignment posts. Applicant respectfully submits that these latter two layers are not the alignment posts but are conventionally provided for the protection of underlying structures. In the case of the Wong et al. invention for the protection of metal alignment posts and metal pixels. Applicant finally refers to claim 8 which specifies the use of "forming insulating material alignment posts", subsequent dependent claims to claim 8 specify the details of how these insulating material alignment posts are created, providing a process that is at significant variance with the process of Wong et al. since the latter process uses metal for the creation of a reflective plate.

Moore et al. provides for the formation of a thin liquid crystal transducer cell having self-aligned support pillars. A

significant portion of the Moore et al. invention addresses parts of the required processing sequence that do not relate to the instant invention, since the instant invention addresses, see claims 1 and 8, the formation of insulating material alignment posts (that are associated with active device structures). In view of this, only these portions of Moore et al. that concern themselves with the formation of support pillars 305, Fig. 3CC, need to be addressed here.

To create support pillars 305, Moore et al. Figs. 3AA through 3CC and corresponding text:

- provide a layer 314, Fig. 3AA - 3AC of lower interconnect metal
- deposit a layer 312 of upper intermetal dielectric over the surface of layer 314
- create a via through the layer 312, the via is filled with a metal (tungsten) to established a point of electrical contact on the surface of layer 312 with layer 314, and
- deposit a thick layer of silicon nitride over the surface of layer 312, patterned and etch to create support pillars 314 on the surface of layer 312 of upper intermetal dielectric.

The balance of the Moore et al. invention addresses the formation of a reflective pixel electrode that is aligned with the created support pillars.

From the above the following conclusions can be drawn:

- the support pillars 305 that are created by Moore et al. comprise silicon nitride, the support pillars that are created by the instant invention comprise silicon oxide (support pillars 71, Fig. 8) or amorphous silicon (support pillars 101, Fig. 10) or silicon nitride (support pillars 122, Fig. 13) or an insulation material (support pillars 153, Fig. 17) or polysilicon (support pillars 191, Fig. 19); since the support pillars that are created by Moore et al. comprise and are limited to silicon nitride, the instant invention provides for the creation of support pillars of a variety of materials, using a variety of processing sequences and resulting in a variety of support pillars that can be used for and adapted to a variety of applications
- the support pillars that are created by Moore et al. comprise silicon nitride only, the support pillars of the instant invention comprise an optical interference layer in addition to an optical interference multilayer stack; the methods and limitations that apply for the creation of the optical interference multilayer stack and the optical interference

layer is further detailed in claims 3 through 7 of the invention

- the support pillars that are created by Moore et al. comprise silicon nitride only, the etching of a layer of silicon nitride is well known in the art; by contrast, the invention provides for, as pointed out, a variety of materials for the support pillars in further provides, for each of the material, a method of etching the material, see claims 9, 12, 13, 17, 21 and 22, 23, 24, 25 , 27, 29, 32; examples that apply to the instant invention: silicon dioxide posts (created by) wet etching, amorphous silicon post (created by) plasma etching, etc.
- the instant invention creates the support posts over the surface of a layer of OIL; Moore et al. create support posts over the surface of a layer 212 of dielectric; the functionality of the liquid-crystal display that is formed using the support pillars of the invention is therefore completely different from the functioning of the liquid-crystal display that is created by Moore et al.; specifically, Moore et al. create support pillars that are adjacent to the reflexive pixel electrode 308/321, Fig. 3FC; the support pillars of the instant invention can be located in any position with respect to the pixels of the display, no symmetry of construction of the support pillars (with respect

to the pixels) is required meaning that a large number of support pillars can be created over the surface of a wafer for additional support

- the support pillars of the invention are created on the surface of a Optical Interference Layer (OIL), the support pillars of Moore et al. are places on the surface of a layer (312, Fig. 3FC) of dielectric and are placed inside openings that have been etched through the pixel electrode 306, Fig. 3DB of Moore et al. (layers 308/310 of Fig. 3FC); this also provides for different support for the support pillars.

While applicant acknowledges the teachings of Wong and Moore as cited by the Examiner, and although applicant does not necessarily agree that the Examiner's arguments show sufficient and proper basis for suggestion or motivation to modify or combine Wong with Moore, applicant nonetheless also asserts that there is absent within the portions of Wong and Moore or any combination thereof, as cited by the Examiner, an express or inherent teaching of each and every limitation within applicant's invention as taught and claimed within claim 8 of the instant invention.

In this regard, applicant claims that there is absent form

the portions of Wong and Moore, or any combination thereof, as cited by Examiner, a teaching of forming insulating material alignment posts combined with optical interference layers as supported by claim 8 and the dependent claims to claim 8, which specify the details of how these insulating material alignment posts are created, providing a process that is at significant variance with the process of Wong et al. since the latter process uses metal for the creation of a reflective plate. The instant invention provides for the creation of support pillars of a variety of materials, using a variety of processing sequences and resulting in a variety of support pillars that can be used for and adapted to a variety of applications.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claim 8 under 35 U.S.C 103(a) as being unpatentable over Wong (US 6,027,999) in view of Moore (US Patent 6,124,912), be withdrawn.

2. Reconsideration of the rejection of claim 9-12 under 35 U.S.C 103(a) as being unpatentable over Wong (US 6,027,999) in view of Moore (US Patent 6,124,912) as applied to claim 8 above, further in view of Colgan (US Patent 5,831,710) is respectfully requested based on the following.

The relative merits of Wong and Moore with respect to the instant invention have been discussed in detail above and are enclosed herein as this time by reference.

Colgan et al. (US Patent 5,831,710) provides for the following:

- a layer 43, Fig. 3, of etch stop material deposited over the surface of a substrate 40
- an insulating layer 44, deposited over the layer of etch stop material
- etching the layer 44 of insulating material, exposing the etch stop layer 43 and therein created pixel contacts 41; the remaining pattern of layer 44 form support posts
- a translucent common electrode 51, Fig. 5, over which a translucent cover 50 are deposited support by the support posts of patterned layer 44
- wall segment rows 25, Fig. 2, are provided to control out-diffusion of an adhesive 52, Fig. 6, toward the pixel locations.

In sum: Colgan et al., see ABSTRACT, provides a structural principle for controlling the gap and the area around the periphery of a liquid display by formation of an insulating

layer, which is patterned and etched such that after the etch of the insulating layer remain in place supporting posts and "contaminant diffusion inhibiting segmented walls".

Colgan et al. does therefore not provide for creating alignment posts and optical interference layers directly on liquid-crystal-on-silicon displays. Specifically, Colgan et al. does not provide for providing, as specified in claim 8 of the instant invention, the following:

- forming a first metallic layer over the surface of a wafer
- forming a second metallic layer over the first metallic layer, the second metallic layer is used both for connections and for bonding pads
- forming a silicon dioxide insulation over the second metallic layer
- forming a third metallic layer over the layer of silicon dioxide;
- patterning and etching the third metallic layer to provide that each pixel retains the third metallic layer, which shall act as a mirror reflector for light incident upon the liquid-crystal-on-silicon display device, and

- depositing optical interference layers of silicon oxide or silicon nitride or silicon oxide or silicon nitride over the third metallic layer and the silicon dioxide layer.

Supporting and dependent claims 9-12, further additional dependent claims, significantly expend the instant invention, to quote a limited number of these extended specifications, all of which are not provided by Colgan et al.:

- claim 9, the alignment posts are formed by a process of silicon dioxide by wet etching
- claim 10, a silicon dioxide layer of thickness between about 0.1 to 5 microns to achieve a desired height of the alignment posts
- claim 13, the alignment posts are formed by the process of amorphous silicon by plasma etching upon the silicon substrate, and
- claim 17, the alignment posts are formed by the process of silicon nitride by plug filling upon the silicon substrate.

The same conclusion is apparent when comparing Colgan et al. either singly or in combination with Wong and Moore: the instant invention is unique and different from either Wong and Moore and Colgan et al. or any combination thereof.

To combine the teachings of Wong and Moore and Colgan et al. is not obvious, since there is no suggestion or motivation in the teachings of any of these patents of the present invention. The instant invention specifically provides a method of forming a device structure that combines insulating materials for alignments posts and optical interference layers associated with an active device structure in a silicon body. In the context of the instant invention, and not either supported by or inferred by or referred to by Wong and Moore and Colgan et al. singly or in combination thereof, provides a first and second metallic layer over the surface of a substrate, whereby the second layer of metal is used both for connections and for bonding pads, forms a layer of silicon dioxide insulation over the second metallic layer, forms a third metallic layer over the layer of silicon dioxide, patterns and etches the third metallic layer to create mirror reflectors for incident ligh, and deposits an optical interference layer over the third metallic layer and the silicon dioxide layer.

Applicant therefore asserts that there is absent within the portions of Wong and Moore and Colgan et al. or any combination thereof, as cited by the Examiner, an express or inherent teaching of each and every limitation within applicant's

invention as taught and claimed within claim 8 and the therewith specified supporting claims.

None of the applied or known references address the invention as shown in the amended claim 8. The invention is believed to be patentable over the prior art cited, as it is respectfully suggested that the combination of these various references cannot be made without reference to Applicant's own invention. None of the applied references address the problem of creating alignment posts and optical interference layers directly on liquid-crystal-on-silicon displays. Applicant has claimed his process in detail. The processes of Figs. 4-20 are both believed to be novel and patentable over these various references, because there is not sufficient basis for concluding that the combination of claimed elements would have been obvious to one skilled in the art. That is to say, there must be something in the prior art or line of reasoning to suggest that the combination of these various references is desirable. We believe that there is no such basis for the combination. We therefore request Examiner Jeff B. Vockrodt to reconsider his rejection in view of these arguments and the amendment to the claims.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claim 8 under 35 U.S.C 103(a) as being unpatentable over Wong (US 6,027,999) in view of Moore (US Patent 6,124,912) as applied to claim 8 above, further in view of Colgan (US Patent 5,831,710), be withdrawn.

Other Considerations

No new independent or dependent claims have been written as a result of this office action, no new charges are therefore incurred due to this office action.

SUMMARY

The invention provides five new methods for the formation of an improved liquid-crystal-on-silicon display. The device structure is enhanced by the photolithographic creation of alignment posts among the mirror pixels of the micro-display. The five methods accommodate the fabrication of an optical interference multilayer, which improves the image quality of the reflected light. The five methods of the invention provide:

- silicon dioxide posts by wet etching
- amorphous silicon posts by plasma etching
- silicon nitride posts by plug filling

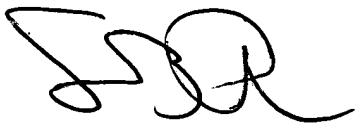
- insulation material posts by lift-off, and
- polyimide posts by photosensitive etching.

It is requested that should Examiner not find the claims to be allowable that he call the undersigned Attorney at his convenience at 845-452-5863 to overcome any problems preventing allowance.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned:

"Version with markings to show changes made."

Respectfully submitted,



Stephen B. Ackerman (Reg. No 37,761)

Version with markings to show changes made

Please amend the claims as follows.

8. (Twice Amended) A method of forming a device structure that combines insulating materials for alignments posts and optical interference layers associated with an active device structure in a silicon body comprising:

providing a silicon wafer having a pattern of active device structures therein and thereon;

forming a first metallic layer over the surface of said wafer;

forming a second metallic layer over [the] said [silicon oxide] first metallic layer, which is used both for connections and for bonding pads;

forming a silicon dioxide insulation over [the] said second [metal] metallic layer;

forming a third metallic layer over [the surface of] said layer of silicon dioxide;

forming a photoresist mask over [the] said third metallic layer having a covering over [the] planned pixel locations of [the] said liquid-crystal-on-silicon display device;

removing [the] said third metallic layer not covered by [the] said photoresist mask;

removing [the] said photoresist mask to provide that each said pixel retains said third metallic layer, which shall act as a mirror reflector for [the] light incident upon said liquid-crystal-on-silicon display device; and

depositing optical interference layers of [silicon oxide/silicon nitride/silicon oxide/silicon nitride] silicon oxide or silicon nitride or silicon oxide or silicon nitride over said third metallic layer and said silicon dioxide layer.

9. (Amended) The method of claim 8 wherein said alignment posts are formed by the process of silicon dioxide by wet etching upon [the] said silicon substrate.

11. (Amended) The method of claim 9 for forming a photoresist mask over [the] said silicon oxide layer to cover the location of each planned alignment post.

12. (Amended) The method of claim 9 for removing [the] said silicon oxide layer to form [the] said alignment posts with a wet etch (such as HF or buffered HF), and removing [the] said photoresist mask.

13. (Amended) The method of claim 8 wherein said alignment posts are formed by the process of amorphous silicon by plasma etching upon [the] said silicon substrate.

15. (Amended) The method of claim 13 for forming a photoresist mask over [the] said amorphous silicon layer to cover the location of each planned alignment post.

16. (Amended) The method of claim 13 for removing [the] said amorphous silicon to form [the] said alignment posts by plasma etch, and removing [the] said photoresist mask.

19. (Amended) The method of claim 17 for forming a photoresist mask over [the] said PECVD oxide layer to expose the location of each planned alignment post.

20. (Amended) The method of claim 17 for forming post cavities by plasma etching of [the] said PECVD oxide layer.

21. (Amended) The method of claim 17 for plasma enhanced chemical vapor deposition of silicon nitride into [the] said post cavities.

22. (Twice Amended) The method of claim 17 for etch-back removal of said silicon nitride, except that silicon nitride deposited in [the] said post cavities.

23. (Amended) The method of claim 17 for removing the PECVD oxide layer by wet etch (such as HF or buffered HF) to form [the] said silicon nitride alignment posts, and removing [the] said photoresist mask.

24. (Amended) The method of claim 8 wherein said alignment posts are formed by the process of insulation material by lift-off upon [the] said optical interference layer OIL.

26. (Amended) The method of claim 24 wherein a photomask is used to form [the] said cavities in [the] said silicon monoxide by a CF4 plasma etching of the silicon monoxide, after which the silicon monoxide serves as a mask for an oxygen plasma etching of [the] said two-micron bottom photoresist.

28. (Amended) The method of claim 24 for removing said bottom photoresist layer by lift-off with an ultrasonic bath, leaving [the] said alignment posts.

31. (Amended) The method of claim 29 for exposing [the] said photosensitive polyimide at the location of each planned alignment post.

32. (Amended) The method of claim 29 for developing and removing [the] said photosensitive polyimide to leave [the] said alignment posts in the location of the exposed polyimide described herein, and removing [the] said photoresist mask.